SECTION 1 Multiple Choice Question (MCQ)

- This section contains **TEN (10)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, darken the bubble corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : $+3$ If **ONLY** the bubble corresponding to the correct option is darkened.
Zero Marks : 0 If none of the bubble is darkened (i.e., the question is unanswered).
Negative Marks : -0.75 In all other cases.

Q.1 *The reaction that is accompanied by an increase in entropy is*

(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
(B) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
(C) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
(D) $3C_2H_2(g) \rightarrow C_6H_6(g)$

Q.2 *The heat absorbed/released by the system is zero for an*

(A) isothermal process
(B) adiabatic process
(C) isochoric process
(D) isobaric process

Q.3 *The unit of rate constant for a first order reaction is*

(A) $mol\ L^{-1}s^{-1}$
(B) $mol^{-1}L\ s^{-1}$
(C) $mol^{-2}L^2s^{-1}$
(D) s^{-1}

Q.4 *The INCORRECT statement regarding accuracy and precision, is*

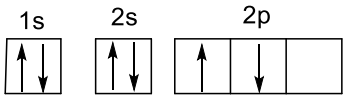
(A) Repeatability of measurements is called precision.
(B) Correctness of measurements is called accuracy.
(C) If a measurement is precise, then it is also accurate.
(D) To get good precision, a scientist tries to repeat the measurement in exactly the same way each time.

Q.5 *The process which results in an increase in atomic number is*

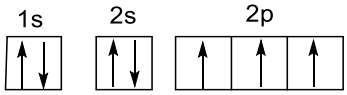
(A) gamma emission.
(B) positron emission.
(C) beta emission.
(D) alpha emission.

Q.6 *Among the ground state electronic configuration of elements, the correct one is*

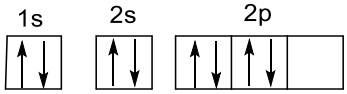
(A) Carbon :



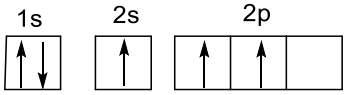
(B) Nitrogen :



(C) Oxygen :



(D) Boron :



Q.7 *If surface tension of water at 25 °C is 72.0 mN m^{-1}, then its surface tension at 90 °C will be*

(A) lower than 72.0 mN m^{-1}.
(B) higher than 72.0 mN m^{-1}.
(C) equal to 72.0 mN m^{-1}.
(D) equal to zero.

Q.8 *Among the following amines, the one that is NOT a tertiary amine is*

(A) propane-2-amine.
(B) trimethylamine.
(C) *N,N*-diethylisopropylamine.
(D) *N,N*-dimethylethylamine.

Q.9 *The molecule that contains the most acidic proton is*

(A) benzene.
(B) ethylene.
(C) acetylene.
(D) cyclopentane.

Q.10 *Among the following molecules, the one that is NOT aromatic is*

(A) naphthalene.
(B) pyridine.
(C) cyclopentadiene.
(D) benzene.

SECTION 2 SDI

- This section contains **TEN (10)** questions.
- The answer to each question is a **SINGLE DIGIT NON-NEGATIVE INTEGER (SDI)**.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If **ONLY** the bubble corresponding to the correct answer is darkened.
  Zero Marks : 0 In all other cases.

Q.11 *The enthalpy of sublimation and enthalpy of fusion of an element X(s) are 10 kJ mol^{-1} and 3 kJ mol^{-1}, respectively. The enthalpy of vaporization (in kJ mol^{-1}) of X(l) is_____.*

Q.12 *At a given temperature, the ratio of root mean square speeds of gaseous H_2 and O_2, $\frac{v_{rms}(H_2)}{v_{rms}(O_2)}$, is _____. [Molar masses (in g mol^{-1}): H_2 = 2, O_2 = 32]*

Q.13 *For a reaction, the plot of $\ln k$ versus $^1/_T$ yields slope equals to –4 (in K). If the activation energy (in J mol^{-1}) of the reaction is $x \times R$, the value of x is _____. (R is the universal gas constant in J K^{-1} mol^{-1})*

Q.14 *There are _____significant figures in 0.06030*

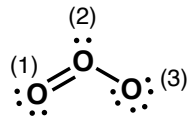
Q.15 *The coefficient of the permanganate ion when the following equation is balanced, is _____.*

$$MnO_4^- + Br^- + H^+ \rightarrow Mn^{2+} + Br_2 + H_2O$$

Q.16 *For the reaction $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$ at temperature T, the difference between change in the enthalpy (ΔH) and change in the internal energy (ΔU), "$\Delta H - \Delta U$", is $-x \times RT$. The value of x is _____. (R is the universal gas constant and gases can be considered to be ideal)*

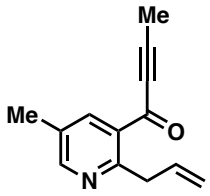
Q.17 *Consider the following four anions: sulphide, nitrate, sulphite, and carbonate. Among them, the total number of anions that would give colorless gases during their preliminary tests with dilute H_2SO_4 is _____.*

Q.18 *The Lewis dot structure of O_3 is shown below:*

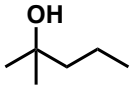


The formal charge on the oxygen atom labelled as (1) is _____.

Q.19 *The total number of sp^2 hybridized carbon atoms present in the following molecule is _____.*



Q.20 *The maximum number of possible alkenes that can be obtained from acid-catalyzed dehydration of the following molecule is _____.*



SECTION 3: Paragraph based MCQ

- This section contains **FIVE (05)** paragraphs.
- Based on each paragraph, there are **TWO (02)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : $+3$ If **ONLY** the bubble corresponding to the correct answer is darkened.
  Zero Marks : 0 If none of the bubble is darkened (i.e., the question is unanswered).
  Negative Marks : -0.75 In all other cases.

PARAGRAPH I

4 moles of P undergo reaction to give 4 moles of Q at equilibrium in a 1 L container according to the reaction (no Q is present in the beginning of the reaction)

$$P(g) \rightleftharpoons 2\,Q(g)$$

Q.21 *The equilibrium constant (K_c) for the reaction is*

(A) 2 (B) 4 (C) 8 (D) 16

PARAGRAPH I

4 moles of P undergo reaction to give 4 moles of Q at equilibrium in a 1 L container according to the reaction (no Q is present in the beginning of the reaction)

$$P(g) \rightleftharpoons 2\,Q(g)$$

Q.22 *If the rate of consumption of P is 1 mol L^{-1} s^{-1}, the rate of formation (in mol L^{-1} s^{-1}) of Q is*

(A) 1 (B) 2 (C) 3 (D) 4

PARAGRAPH II

*The solubility product constant, K_{sp}, of a sparingly soluble halide salt **MX** is 1×10^{-10} at 300 K.*

Q.23 *The solubility (in $mol\ L^{-1}$) of the salt **MX** at 300 K is*

(A) 1×10^{-5} (B) 2×10^{-5}
(C) 1×10^{-10} (D) 2×10^{-10}

PARAGRAPH II

*The solubility product constant, K_{sp}, of a sparingly soluble halide salt **MX** is 1×10^{-10} at 300 K.*

Q.24 *At 300 K, the solubility (in $mol\ L^{-1}$) of the salt **MX** in the presence of 0.1 M NaX is*

(A) 1×10^{-5} (B) 1×10^{-6}
(C) 1×10^{-8} (D) 1×10^{-9}

PARAGRAPH III

Titration between oxalic acid dihydrate (a diprotic acid, hereafter referred to as OA) and sodium hydroxide is a typical acid-base titration. Phenolphthalein is used as an indicator. The appearance of a permanent light pink color indicates the end point. This titration method helps in determining the unknown concentration of sodium hydroxide using a standard OA solution. (Molar mass of OA = 126 g mol^{-1})

Q.25 *The amount (in g) of OA required to make 0.5 L of 0.1 M solution is*

(A) 126 (B) 12.6 (C) 63.0 (D) 6.30

PARAGRAPH III

Titration between oxalic acid dihydrate (a diprotic acid, hereafter referred to as OA) and sodium hydroxide is a typical acid-base titration. Phenolphthalein is used as an indicator. The appearance of a permanent light pink color indicates the end point. This titration method helps in determining the unknown concentration of sodium hydroxide using a standard OA solution. (Molar mass of OA = 126 g mol^{-1})

Q.26 *A titration of 20 mL of 0.1 M solution of OA consumed 16 mL of sodium hydroxide solution. The concentration (in M) of this sodium hydroxide solution is*

(A) 0.250 (B) 0.125 (C) 0.0625 (D) 0.160

PARAGRAPH IV

*The reaction of 1-bromopropane with concentrated alcoholic KOH gives compound **X**. Reaction of compound **X** with HBr in acetic acid gives 2-bromopropane as the major product.*

Q.27 *Compound **X** is an*

(A) aldehyde (B) alcohol (C) alkene (D) alkyne

PARAGRAPH IV

*The reaction of 1-bromopropane with concentrated alcoholic KOH gives compound **X**. Reaction of compound **X** with HBr in acetic acid gives 2-bromopropane as the major product.*

Q.28 *1-Bromopropane and 2-bromopropane are*

(A) positional isomers
(B) enantiomers
(C) functional isomers
(D) metamers

PARAGRAPH V

The reaction of one equivalent of benzene (molar mass = 78 g mol^{-1}) with one equivalent of acetyl chloride in the presence of anhydrous $AlCl_3$ gave acetophenone (molar mass = 120 g mol^{-1}) as the major product.

Q.29 *This reaction is an example of*

(A) Friedel-Crafts alkylation
(B) Friedel-Crafts acylation
(C) Sandmeyer's reaction
(D) Cannizzaro reaction

PARAGRAPH V

The reaction of one equivalent of benzene (molar mass = 78 g mol^{-1}) with one equivalent of acetyl chloride in the presence of anhydrous $AlCl_3$ gave acetophenone (molar mass = 120 g mol^{-1}) as the major product.

Q.30 *If the reaction gave 120 g of the acetophenone from 156 g of the benzene, the yield of the reaction is*

(A) 60%
(B) 50%
(C) 78%
(D) 100%